Space Weather Technical Forecast

Issued on Friday, 26 April 2024 at 13:08 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Risk of R, G and S-scale events all falling during the coming four-day period.

Solar Activity: Solar activity measured by GOES16 was Moderate in the past 24 hours, with the peak flare being an impulsive M1.3 observed from part of the off-going agglomeration of sunspot regions on the southwestern solar horizon at 25/1712UTC. The flare trace itself showed contrasting behaviours of fewer large C and M-class flares, but at the same time exhibited a gradually rising background flux to more comfortably lie within C-class. The gradual rotation onto the limb of this mass of active regions in the past 24 hours has reduced the overall number of sunspot groups to around ten as of the last solar analysis.

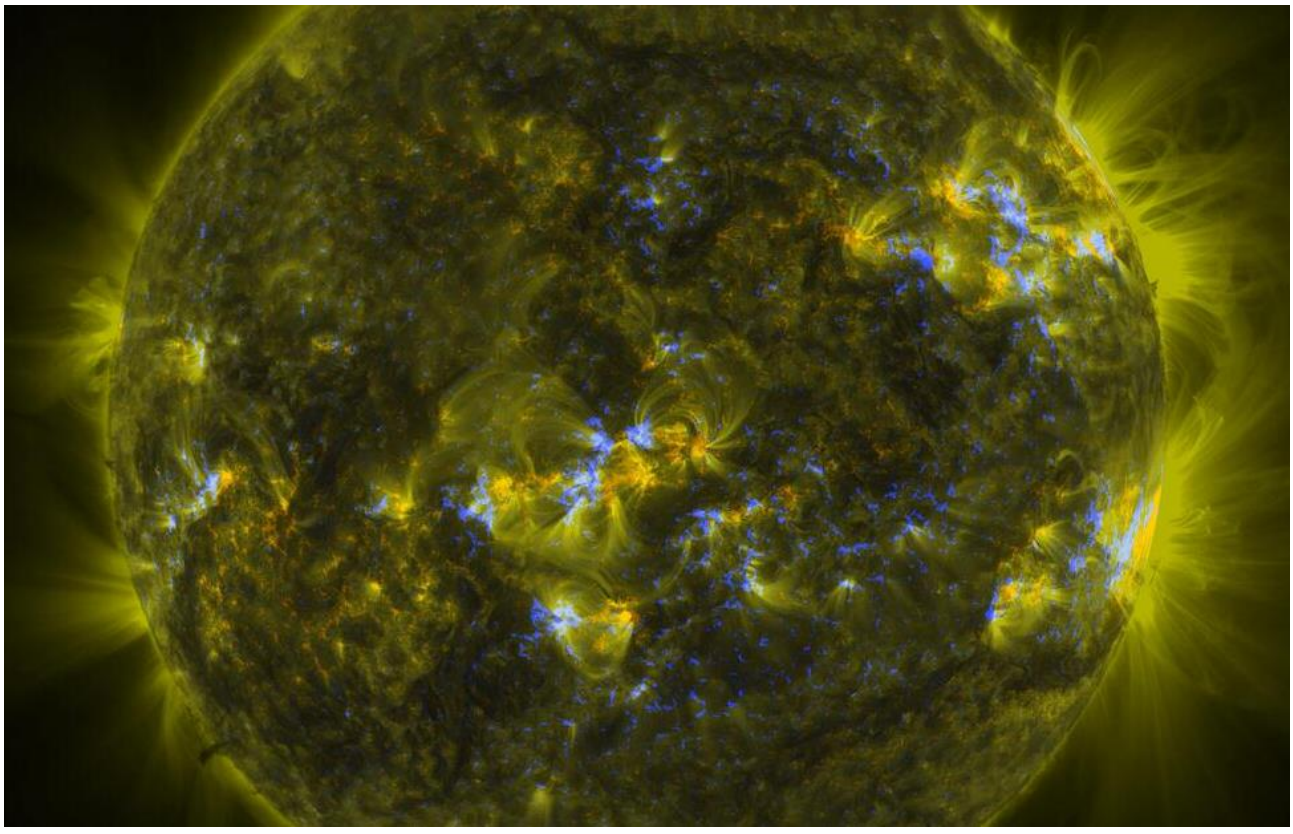

Figure 0: SDO AIA171 and HMIBC composite image from 26/1130UTC showing the strong assymetry in sunspot regions and emanating flux from east to west across the disc.

Much of the surviving disc comprises smaller regions than of late, although there are some more developmental areas - namely AR3658 in the southwest, with a trailing spot growing to its southeast. It has been generally true of the period that some of the remining larger and more complex regions showed decaying areal trends, with these groups including AR3654 near centre disc, and AR3648 in the northwest, the latter showing Beta-Gamma complexity.

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The cadence of observed Coronal Mass Ejections (CMEs) remains relatively high on coronagraphs, although those observed in the period were either high latitude limb features or else far-sided. No new observed events have been added to the CME roster in the 24 hours.

Solar Wind / Geomagnetic Activity: Solar winds observed by ACE at L1 showed an initial slow regime, transitioning to minor CME influence shortly after UTC midnight. The CME responsible is not known, however STEREO A MAG and PLASTIC measurements show brief glimpses of a similarly-timed arrival amongst data gaps, which perhaps hints at an western solar hemisphere CME candidate given STEREO's position relative to Earth. This is, however, conjectural - and scarcely narrows the candidate list given the rate of emissions from regions like Ex-AR3638.

The solar wind speed initially showed a slow decline from 325 to 300km/s before undergoing a step-change to a peak of around 375 before settling nearer by the period's end. The solar wind density signal was less conclusive given the low values involved, but perhaps showed a slight increase within single figures ppcc after the arrival. The IMF, which had been steady near 5nT in the tail of the UTC day of Thursday, rose to a high of 10nT after the CME, with the north-south component mainly anti-aligned with respect to Earth's field and falling to a nadir of -9nT, with only a very weak co-aligned component of 0-1nT prior to this. The phi angle was mostly negative (towards the Sun), showing a brief foray into positive between 26/0200-0300UTC.

The net result of the above solar wind measures was nevertheless subdued, perhaps because of the low speeds and densities involved, rising from Quiet to Unsettled and a provisional peak of Kp 3+ in the 06-09UTC interval.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) observed at GOES18 was very slightly above resting Background levels (since 24/1400UTC) with the culprit most likely to be proton emission following southwestern quadrant M-class activity. Even at peak this registered at fractions of a pfu (where 10pfu is S1).

High energy electron flux (greater than 2MeV) observed at GOES16 initially showed a diurnal oscillation peaking at High flux and 1670pfu at 25/1030UTC, but underwent suppression at GEO into the current UTC day - likely the result of minor CME influence. The trace has since languished within low Normal Background levels. The associated 24-hour fluence remained below Active (1e8 integrated flux), with an initial rising trend since reversing into the current UTC day, with a peak during the period of near the 7.2xe7 integrated pfu seen at 26/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: The X-ray forecast should see decreasing risks overall into the coming UTC weekend, as the cluster of southwestern regions more fully rotates off the facing side. Likely M-class activity should fall to a Chance during this time, with X-class showing a similar decrease within a Slight Chance.

Solar Wind / Geomagnetic Activity: There is now a reduced risk of further minor CME influence during the first half of the four-day period after the passage of a minor transient in the current UTC day. Any CME may combine with the CIR leading CH27/+ into the coming UTC weekend to perhaps give a peak Slight Chance of G1 as a result. From here, the chances of further such incidences should fall, with winds emanating from lower solar latitude CH29/+ and CH30/+ perhaps glancing Earth in turn into the new UTC week. The result is that more reliably Quiet geomagnetic conditions should develop later in the period.

Energetic Particles / Solar Radiation: High energy proton flux is likely to remain at Background levels, but with a daily Slight Chance of reaching the S1/Minor Radiation Storm threshold now judged to gradually reduce later in the four days with the continuing passage of the southwestern

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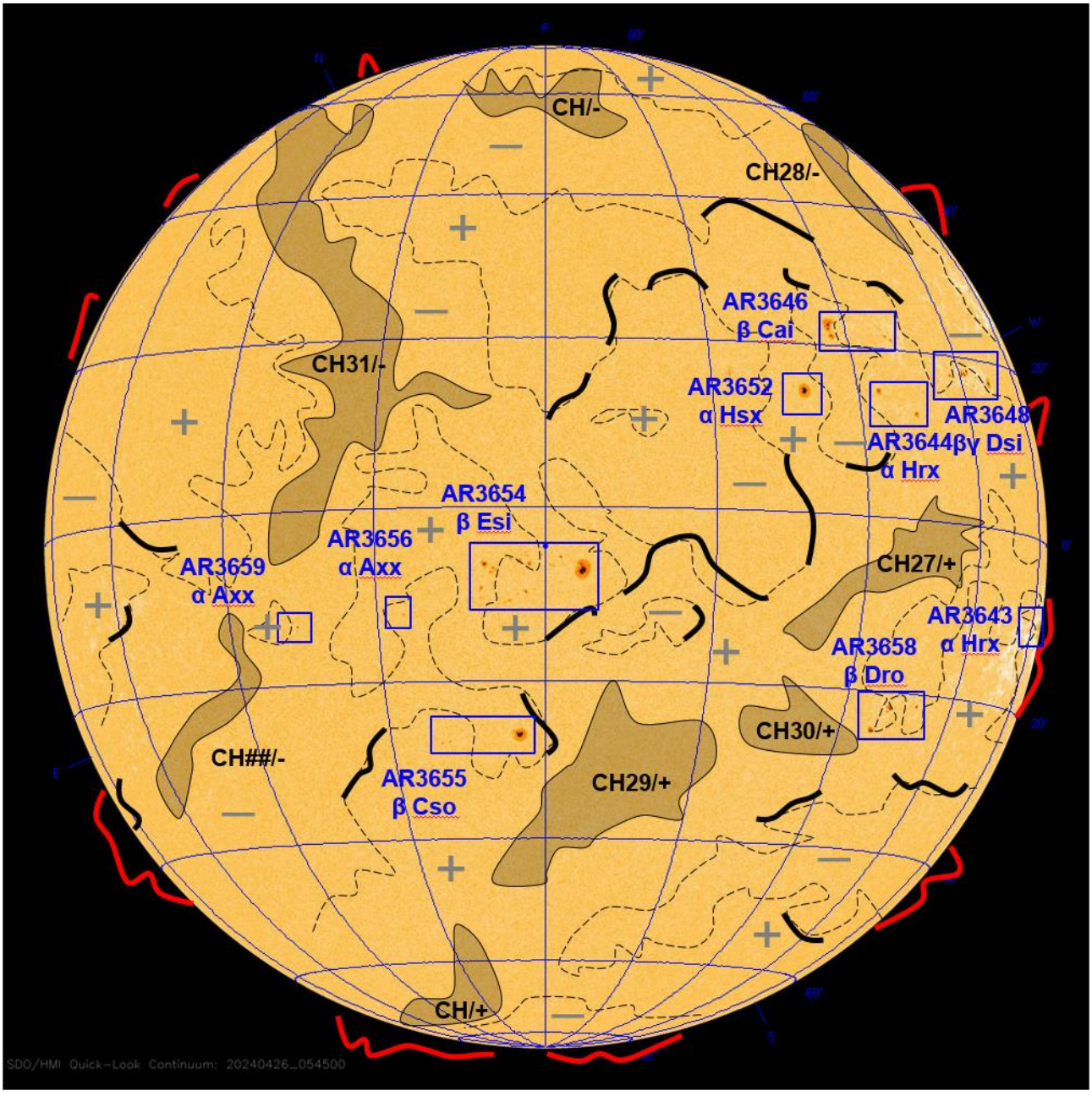
cluster of sunspot groups onto the far side.

High energy electron flux is likely to be suppressed at GEO by minor anticipated CME and fast wind arrivals during the period. While a degree of recovery is likely into the new UTC week, the expected relatively small scale of inbound features may mean that the associated 24-hour electron fluence only has a Slight Chance of reaching similar highs to those seen on Thursday 25 April by the end of the four days.

Figure 1. Solar Analysis Valid 26/0545UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The risk of G-scale events is considered both 'low' and 'lowering' for the period as a whole, and is largely an expression of reduced confidence at first (as much as any expectation of G1 activity). This is the result of the spate of CMEs released in the past week or so from regions such as Ex-AR3638, which is now sufficiently far west so as not to further add to the tally of inbound CME glances. One such CME arrived in the current 24-hour period, however it is not possible to ascribe this to any one outstanding event and remove it from MOSWOC Enlil, and the risk remains generalised for the next 24 hours or so of further such minor arrivals.

The fast wind-based forecast is of slightly higher confidence compared to the transient story, with a train of successive coronal holes in the form of CH27, 29 and 30 perhaps making themselves felt in the period, with a successively reducing likelihood as they lie progressively further south on the disc and further from the ecliptic plane. These are persistent features, with the leading edge of CH27/+ perhaps a little ahead of the previous rotation, and in this regard MOSWOC Enlil perhaps remains a little too slow to show its influence. Speeds arising from this feature may reach Elevated levels of 500-550 km/s based on the previous rotation, however, in part because of the polarity being positive, impacts are most likely expected to be muted.

All considered, the main risk of a Slight Chance of G1 will most likely be tied to the ongoing negative Bz period with the overnight UTC CME arrival, perhaps bolstered by any influence from any CIR leading CH27, and any further minor CME glances. All of these aspects should become less likely as the UTC weekend develops, such that the chances of further Active or G1 intervals become low into the new working week, barring new developments.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	15	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

MOSWOC Enlil still has a now much-reduced number of CMEs with minor glancing components of Earth due inside the first two UTC days of this period, although the most likely state of affairs is for these to miss.

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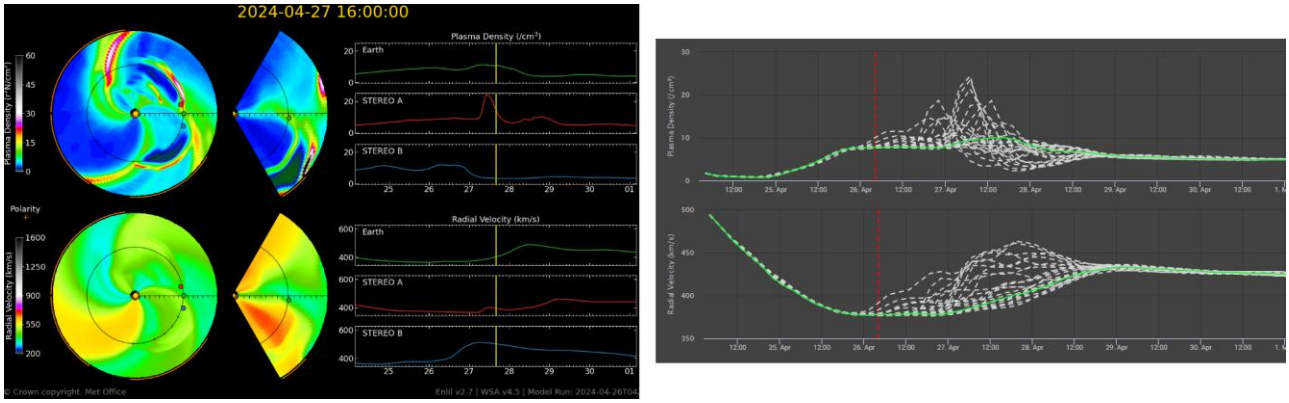
Figure 2: MOSWOC Enlil run (badge time 26/0400UTC) paused around the time of a final glancing inbound CME during the UTC afternoon of Saturday 27 April. The timing and presence of this feature is low confidence, and is instead representative of one of a number of glancing incidence CMEs observed in the period. Confidence should improve as this period evolves, with any future individul arrivals more likely to be uniquely indentifiable for being better separated in time and space.



Radio Blackouts - X-Ray Flares:

The Earth-facing disc is now depopulating relative to the recent past, with numerous large and complex regions now lying on or near the off-going western solar horizon. This process should be complete to a large degree into the second half of the UTC weekend, leading to the risk of further M-class activity falling from Likely to a Chance, while X-class shows a similar decline within Slight Chance.

Far-side helioseismographs show a relatively large signal covering a large portion of the far-sided eastern hemisphere, although there is relatively little expected in this location from persistence. This remains something to be monitored for any increase later in the four days, however for now a watching brief is maintained,, and the flare risk is overall decidedly directed downwards.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**R1-R2 M Class**	No	60	50	30	30
Very Active	**R3 to R5 X Class**	No	15	10	5	5

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Figure 3: SIDC ROB visualation of C-class flares and above at PROBA-2 in the 24 hours to 26/1130UTC, showing the dominance of the offgoing southwestern limb. This is the rationale for the steep drop in daily risk of significant flares beyond 24 hours' time.

Solar Radiation Storms - (High Energy Protons):

High energy proton flux (greater than 10MeV) observed at GOES18 was very slightly above resting Background levels (since 24/1400UTC) with the culprit most likely to be proton emission following southwestern quadrant M-class activity. Even at peak this registered at fractions of a pfu (where 10pfu is S1).

In terms of ongoing risk, care must be taken to account for the now-invisible population of spots lying on or near the southwestern limb, however the overall trend is considered to be a downward risk through a daily Slight Chance of S1 with the continuing passage of the southwestern cluster of sunspot groups onto the far side.

Radiation Storms	**Level (cm^{-2} sr^{-1} s^{-1})**	**Past 24 Hours (Yes/No)**	**Day 1 (00-24 UTC)**	**Day 2 (00-24 UTC)**	**Day 3 (00-24 UTC)**	**Day 4 (00-24 UTC)**
Probability (Exceedance)			**(%)**	**(%)**	**(%)**	**(%)**
Active	**≥ S1**	No	15	10	10	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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Figure 4: Past three days in GOES18 high energy proton flux and potentially linked GOES16 X-ray flare events showing an ongoing very slight enhancement as of 24/1400UTC. The cause is not immediately apparent, however it is assumed to either be a weak response to southwest quadrant activity or else far sided - for the damped and protracted 10MeV curve displayed.

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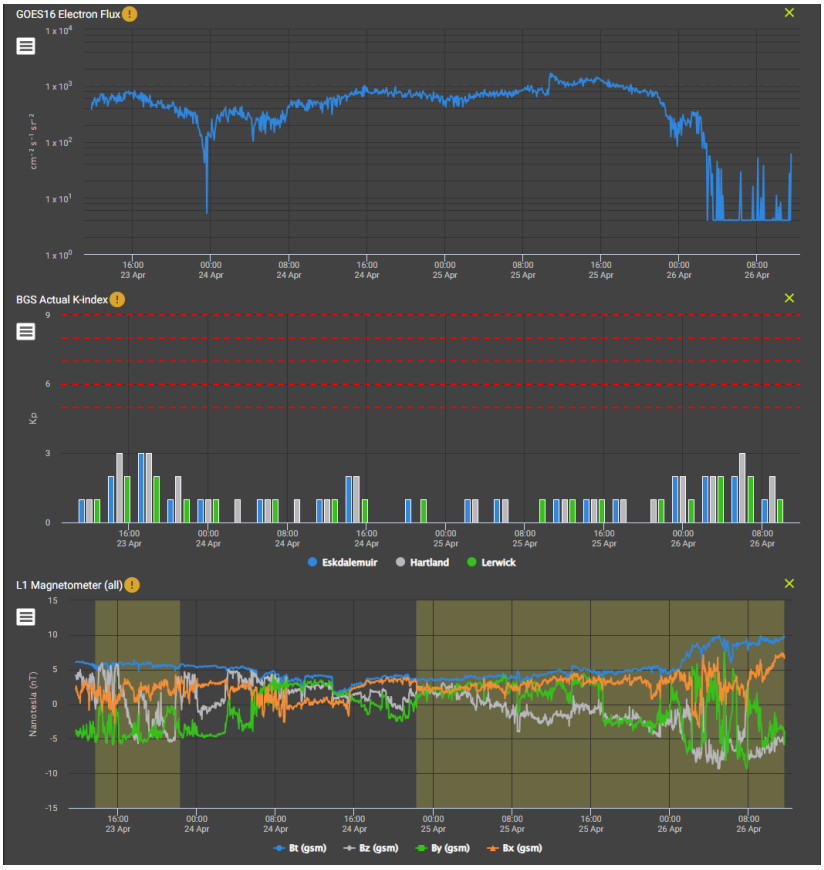
High Energy Electrons Event (≥ 2MeV):

High energy electron flux is likely to be continue to be suppressed at GEO by minor anticipated CME and fast wind arrivals during the period. Any further arrivals/passages are expected to become less obliquely aimed at Earth with time, and the greatest risk of any further dents to the population seen by GOES16 comes in the first 24 hours or so, with CH27 nearest the ecliptic (of the three minor coronal holes at suitable solar longitudes to arrive in the period, CH27, 30 and 29) and with any residual CMEs from the recent spate of activity most likely to cross 1AU.

While a degree of recovery is likely into the new UTC week, the expected relatively small scale of inbound features may mean that the associated 24-hour electron fluence only has a Slight Chance of reaching similar highs to those seen on Thursday 25 April by the end of the four days.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	5	10	20
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 5: Past three days in high energy electron flux at GOES16, showing a hitherto diurnal oscillation to High levels, attenuated at GEO after the inbound weak CME and geomagnetic activity, shown in BGS magnetometer data and L1 IMF at ACE.



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